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A New Model for Generating Mass-Consistent Wind Fields over Continuous Terrain

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As part of the modernization efforts of the Atmospheric Release Advisory Capability (ARAC) project at Lawrence Livermore National Laboratory, we have developed an innovative mass-consistent wind-field model which provides accurate winds on a continuous terrain grid. These fields are then used to drive ARAC's new dispersion model. Our code is based on a variational formulation which minimally adjusts interpolated wind fields to satisfy the mass-consistent constraint. We chose the finite-element method for spatial discretization in order to effectively treat the continuous terrain variable resolution grid using a grid-point representation of the wind fields (in contrast to the flux-based staggered grid representation often used in finite-difference approaches) and to provide a rigorous, flexible treatment of boundary conditions. Two modern iterative solvers, the incomplete Cholesky conjugate gradient (ICCG) and the diagonally scaled conjugate gradient (DSCG), have been implemented for efficient numerical solution of the Poisson equation derived from the variational principle.

The main capabilities of our model include the use of differential weighting for the horizontal and vertical velocity adjustments to reflect the effects of atmospheric stability, the incorporation of map projection factors, the provision of flexible combinations of boundary conditions, and the ability to preserve grid values for cells in which wind observations are located. The code has exhibited satisfactory performance for a number of problems, including the potential flow solution for a hemispheric hill, the Diablo Canyon tracer experiment, and cases involving current meteorological data for the Cape Canaveral and San Francisco Bay regions.

In the final paper, we will discuss the formulation and numerical aspects of the model, present results from some recent applications, and provide an early assessment of the model.

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